“Eridian” is the name of the intelligent species on the planet 40 Eridani A b. Nomenclature explanation: The 40 Eridani system is a trinary system – meaning there are 3 stars involved. Those stars are named Eridani A, Eridani B, and Eridani C. Eridani A is far larger than the other two, so effectively the other two orbit Eridani A. They orbit at distances so far that they would have no effect on the homeworld. They would be brighter than any other stars in the sky, but not even as bright as the Moon is in our night sky.

The homeworld, is the first planet orbiting 40 Eridani A. For reasons I don’t understand, astronomers start the naming of planets at “b”. So if they were describing the planet Mercury (the first planet in our system) it would be Sol b. Earth would be Sol d.

Hence the inconvenient name “40 Eridani A b”.

The word “Eridian” was invented by the novel’s protagonist (Ryland Grace) and fashioned after the name of the star. And due to the inconvenient name that humanity has for the homeworld, the protagonist took to calling it “Erid”.

Homeworld:

Eridani 40 A b really exists and has the following known properties:

- Mass: 8.47 Me
- Semimajor Axis: 0.224 au
- Eccentricity: 0.04
- Orbital period: 42.245 days
- Energy Flux from star: 12537 W/m^2

The following are properties that I made up, but are not in conflict with any known observations:

- Composition: Rocky planet with thick atmosphere – high in metals, low in gaseous oxygen
- Density: 5710 kg/m^3
- Radius: 12835 km
- Atmospheric composition: Mostly ammonia (NH4) with trace amounts of other gasses
    - Thermal conductivity at ground level 0.053 W/(m*K)
- Surface atmospheric pressure: 28 atm
- Average surface temperature: 210°C

The following are things that derive from my made up stats

- Surface gravity: 2.09g (derived from mass and density)
- Strong magnetic field (otherwise the atmosphere would be gone.)
    - The magnetic field is approximately 25 times Earth’s field strength.
- Solar day period: 5.1 hours (actually it’s 18397.44 seconds which is 5.1104 hours) (to dynamo-generate that field)
- Molten metal core (consistent with such a large radius and needed for the field)
- Tectonic plates and volcanism (because of the magma and core)
- Liquid water is present on the surface. The high pressure raises water’s bp to above 210°C

Ecosphere:

The planet has a lush, complex ecosystem that Eridians are just one small part of. The bulk of the energy capture for the ecology is done by airborne microbes that live in the higher parts of the atmosphere. They absorb sunlight and consume the gasses in the air to multiply.

Larger microbes eat them, then small animals eat those larger microbes, etc. Similar to Earth's oceans. There is a "boundary life" layer that is critical to the ecology – they are the creatures that fly, but also come to the ground. Land life preys on those species and fuels the land ecology.

Eridians are the apex predators of the land ecology.

Owing to the thick atmosphere and the sheer volume of microbes and life at various layers, almost no sunlight penetrates all the way to the ground. Again, similar to Earth's oceans. As a result, the land-based creatures (including Eridians) have no eyes or sense of sight.

Appearance:

Eridians have five legs radiating out from a roughly pentagonal thorax. The entire creature is covered with an articulated exoskeleton shell. It will shed pieces as necessary when growing new ones.

The average height of an Eridian, from the ground to the top of the carapace, is about 50cm. But they can stand on three limbs and use two more to reach upward, being effective to a height up to 1.3 meters.

Limbs

An Eridian has five identical limbs spaced evenly around its thorax. Each limb has a ball-and-socket joint at the point of connection to the thorax. The next joint is a hinge joint, similar to a human elbow or knee – located about halfway along the limb. Each limb ends in a trifurcated claw. When the claw is closed, the limb comes to a point (usable as a weapon). It can open to the point that the three prongs are coplanar – allowing it to serve as a foot.

Eridians are "pentadextrous" – they can use any of their 5 limbs for any purpose based on convenience. If they use all 5 for motion, they can be extremely sure-footed on uneven terrain. When using just three, they can move very fast. When idle, an Eridian typicaly stands on three limbs and uses the other two like arms. Though they will transpose which limbs are hands and which are feet whenever comfortable, either for convenience of grabbing something or do to simple fatigue.

They have no concept of "facing" any given direction.

Sight

Eridians have no sense of sight, nor any natural ability to detect electromagnetic radiation.

Hearing

The carapace is surrounded with auricles which cause piezoelectric flashes that lead directly into the fiberoptic nervous system. This provides the Eridian with extremely accurate hearing. Each auricle is tuned to a specific frequency and the carapace has hundreds of thousands of them with varying frequency sensitivities. All this information is sorted out by the brain.

From any ambient noise, the Eridian is able to have a mental image of its three-dimensional environment, much like humans do with sight. They are also aware of the sound absorption qualities of the surrounding matter. In the absence of ambient noise, the Eridian will tap the ground.

Note – the speed of sound on the surface of the homeworld works out to be 555 m/s. (Calculated from adiabatic index of 1.31 for ammonia, molar mass of 0.017031 kg/mol, and temperature of 210°C).

Magnetoreception

Most complex life on the planet, including Eridians, has the ability to sense magnetic fields. This is owing to the extremely strong magnetic field of the planet – roughly 25 times as powerful as Earth's. This is not a discriminatory sense – it's just a directional sense. On their homeworld, an Eridian has an intrinsic knowledge of what direction is north. In space, their ships maintain a light magnetic field to simulate their homeworld. It is not necessary for their health, but it is more comfortable for them.

Language and Communication

Considering their incredible sense of hearing, it's little wonder that Eridians communicate with sound. This is done by means of gas bladder sets inside the body. The air is pushed from one bladder to the other through a finely-controlled aperture. The air goes back and forth. The Eridian has – you guessed it – five such vocal systems.

Humans can emit many different frequencies, but the main form of communication comes from the tongue and mouth. This differentiates the sounds far more than simple pitch changes. Eridians also have a means of communication beyond simple pitch. The can use their five vocal systems to speak in chords. This enables them a very wide variety of "syllables".

Eridians have perfect pitch. C-sharp and C-flat are as unique to them as red and yellow are to us. And they don't need a baseline to compare them to.

The information transfer rate for Eridian speech varies from language to language (languages are diverse on their world just as they are on ours). However, in general, Eridian speech is about 6 times as information dense as human speech. Meaning: on average, if you have a human and an Eridian say the same thing in their native languages at a normal speed for them, the Eridian will take $1/6^{th}$ as long as the human.

Body

Eridians are made mostly of inorganic material. Unlike a human body which is entirely living cells, Eridians have "worker cells" that assemble and maintain the body, but the bulk of their mass is

inorganic. They have a hard carapace which is made of oxidized mineral material. Their internal bone structure is metallic. Their joints are literally hinges. Their “muscles” are powered by water state changes.

From an evolutionary standpoint, an Eridian is similar to what would happen if bees could make a beehive that moved. And then built a brain to tell them what to do. The body is almost like a ship and its crew are the worker cells. While an Eridian can weigh on the order of 400kg, the total organic mass of the body is less than a kilogram.

Blood

The liquid medium that transports necessary elements around the body is made mostly of liquid mercury. This serves as both a heat regulation system as well as transport mechanism for the worker cells. Also, it has numerous other metals (zinc, potassium, sodium, aluminum, tin, thallium, copper, indium, and trace amounts of silver and gold) dissolved within it. These “material” metals are collected and used at needed sites by worker cells.

Circulatory system

An Eridian has two unconnected bloodstreams which are kept at two different temperatures. One is simply the outside ambient temperature (usually about 210°C). This bloodstream is run through heat radiators on the carapace to keep it the right temperature. The Ambient Circulatory System (“ACS”) is contained within blood vessels made mainly of varying types of sodium silicate $(Na_2O)_x{\cdot}SiO_2$, which are created by worker cells.

Where blood vessels have to be flexible, they subdivide into hundreds (sometimes thousands) of capillaries. The smaller diameter allows the ordinarily rigid sodium silicate to be flexible. Then they reconnect into a single large vessel again. The large-bore blood vessels are rigid.

The other system, called the Hot Circulatory System (“HCS”), is kept around 305°C, is much smaller in volume, and contained within blood vessels similar to the ACS, but also lined internally with layers of polycrystalline (Na,Ca)Co2O4. The latter is an extremely efficient thermal insulator. The blood in this system is devoid of worker cells, as they are unable to survive the temperature. Its temperature is maintained in a reservoir, nicknamed the “spleen”, using energy collected via the digestive system.

Blood flow is directed, constricted, and controlled by valves within the vessels. These valves are flaps of flexible material controlled by piezoelectric “micromuscles” (See “Muscular System” below).

Eridians have five hearts, each near the main joint of a leg. This facilitates the vertical pumping of blood up and down the limbs as needed. There is more than enough pressure to keep the blood flowing laterally around the thorax. The hearts work hard. Not only is mercury heavy, but the Eridian homeworld has over double Earth’s surface gravity.

Muscular System

Eridians have two distinct types of muscle: Skeletal muscle, which performs the main macroscopic muscular movement, and “micromuscles”, which exist only inside the bloodstream.

Skeletal muscles are spongey, roughly cylindrical structures surrounded and interspersed with ACS and HCS capillaries. When the instruction from the brain comes to move the muscle, the ACS vessels nearby constrict flow while the HCS vessels increase flow. The muscle itself is full of expandable vesicles that each have a small amount of liquid water in them. The heat from the HCS causes the water to become a gas, expanding the vesicle. Each muscle is made of tens of thousands of these vesicles, and portions can be activated or not activated as needed. The outer sheath of the muscle provides a piston-like behavior overall.

When the instruction comes to relax the muscle, the process is reversed. The HCS vessels stop their flow and the ACS vessels increase to normal. This cools the vesicles to their original temperature and the water returns to liquid form.

It is worth noting that Eridians are semi cold blooded. The ACS temperature is maintained at 210°C, which is about the average outdoor temperature. The boiling point of water in their atmospheric pressure is 230.2°C, meaning every muscle action must first heat the vesicles 20°C and only then does the heat energy start working toward the state change. This liquid-phase heat-up turns out to be negligible compared to the state change energy. The reason the whole ACS isn’t maintained at 230°C is because it would consume more energy to maintain that temperature against the colder outside air than it would save in muscle motion.

Blood vessel flow is controlled by valves and flaps at junction points in the ACS and HCS. These valves and flaps are powered by micromuscles.

Unlike skeletal muscles, micromuscles are not powered by temperature change. They are made of crystal and powered by the piezoelectric effect. A constant micro-voltage potential is constantly maintained between the blood and the outside of the bloodstream. In essence, the rest of the body is “ground”. The highly conductive mercury conveys electrical charge throughout the bloodstream.

A signal comes from the brain via a fiber optic nerve, which causes a chemical change to the blood vessel wall at that point, making it conductive. The resulting current flowing from the blood through the micromuscle causes the piezoelectric effect to deform the crystal. This small but strong deformation is used to curl a flexible flap from one branch to another. Blood pressure then keeps it closed.

In this way, worker cells are not required for any portion of micromuscle movement. This is critical, because worker cells cannot survive inside the HCS vessels.

Water takes far more energy to state-change than other compounds. So the lingering question is why do Eridian muscles use water state change rather than something more efficient? The answer appears to be two-fold.

Firstly, the HCS temperature is higher than the boiling point of water as a means of pathogen defense and sterilization of incoming food. This is far more important than muscle efficiency in the energy-rich environment that is their ecosystem. Because the two bloodstreams were above and below the bp of water, the state-change based muscular system favored water.

Secondly, because heat inertia is key to Eridian metabolism. Water is an extremely good heat battery – with a high heat capacity. This acts as a buffer for overall temperature management.

Dormancy

At irregular intervals, an Eridian will go into a dormant state. But it is a much deeper level of unconsciousness than a human. This dormancy state is so deep the Eridian is helpless. This is the primary reason that social instincts evolved for Eridians – to protect each other while dormant. Essentially they sleep in shifts.

The dormancy state serves many purposes. The brain is semi-active, but mostly dealing with pure life support operations. No conscious thoughts or dreams occur. The Eridian does not experience any sensation of time. It's a similar effect to general anesthetic on a human.

The HCS is allowed to cool to the same temperature as the ACS (around 210°C). This enables worker cells into the HCS to do whatever repairs or maintenance are necessary. This is the only time when the HCS is not at its normal temperature and thus is the only time when worker cells can survive within it. Because there is no temperature gradient for muscles to work the Eridian is literally paralyzed.

During dormancy, the Eridian's hearts do not beat, and bloodflow stops. The worker cells retreat to the colony (see "Colony" further in this document) to conserve energy. Only the workers that service the brain continue their jobs in the colony. However, another class of highly-specialized worker cells begin work. The HCS worker cells move via flagella through the HCS's now-stationary blood supply.

Because the main force of worker cells are in the core, Eridians do not heal anything other than HCS issues while asleep. So, while a sick human should get plenty of rest, a sick Eridian should get plenty of exercise to move the blood around faster.

Conversely, HCS injuries or problems cannot be addressed until dormancy. In cases of severe injury or bleeding of the HCS, dormancy can happen suddenly. This is, functionally, an Eridian going into shock.

Eating and digestion

The mouth of the Eridian is ventral – facing down. When open, food is placed inside, and then the orifice is sealed by worker cells. It spends very little time being an orifice. The opening actually heals over with carapace mineral material. The hunting behavior of an Eridian is to kill many creatures and store them in a collective location. Eridians are a social animal like humans are and they work together to maintain and protect their food storage.

Digestion begins well outside the body. Eridians have an instinctive understanding of which parts of the animal are best to eat and which are less useful.

Part of "eating" for an Eridian is to butcher the carcass and separate out the useful or needed parts. Eridians also have many different types of hunger – similar to cravings that humans have but much more specific and refined. They know what they need to eat at any given time. They use their limbs to grind the desired material together into small pieces. Effectively, their hands are their teeth. This is a product of their evolution, and while it could easily be done via technology, most Eridians prefer to do this themselves – it is a pleasurable sensation to them. Similar to chewing good food for humans.

An Eridian only brings food into its body once per week or so. Its ventral carapace will crack along a pre-weakened spot, and it will eject the waste from the previous feeding cycle. The Eridian will then "eat" the meal it prepared and immediately seal the opening. It will heal within a few hours. This approach to eating is to deal with the very aggressive pathogens in their biosphere

The first phase of digestion is sterilization. The food, in what can be called a stomach, is brought up to HCS temperatures for several days. This kills off any organic material in the sample. This is because the HCS temperature is higher than the boiling point of water at the planet's surface conditions, and life on their planet also requires water. Though there are some viral pathogens have evolved to survive this step – no evolutionary protection is perfect, after all.

From there, digestion is carried out by specialized worker cells. There is no intestinal tract or anything else. They simply collect the needed compounds and elements from the food and leave what they don't want behind to be ejected in the next eating cycle.

Usually there is a dormancy period shortly after eating. The cooldown after food sterilization is best done as a dormancy period (faster) and it conserves energy for the digestion to come. In short – Eridians have "food comas".

Brain and Nervous System

An Eridian's brain is crystalline in structure. Impulses are made of light, generated at the hindbrain. Areas of differing refraction capability are roughly the same as neurons – reinforcing or canceling the flow of light as well as directing it. This nervous system is located mainly in the brain but fiber-optic-like tendrils of crystal convey nerve impulses around the body.

The brain is in the center of the thorax, inside an area known as "the colony". This is also the home of the worker cells. Unlike other parts of the body, the brain needs constant care. At times, worker cells are confined to the colony (see "Dormancy" and "Heat Rejection"). So the brain has to be inside to continue receiving care.

While heavily reliant on the worker cells, it should be noted that the brain is not biological matter and is not itself composed of cells. It is a complex set of refractive materials. Worker cells constantly service the structure to remove impurities that can affect light movement, and they make permanent the short-term refractory changes that the neural network implements. They do this by adding or removing certain elements from the crystal.

The brain is completely suffused with blood – there is no blood/brain barrier like humans have, and there are no blood vessels within it. Worker cells move on their own to service it.

Intelligence is hard to measure and even harder to define. There are many aspects of "intelligence" that Eridians are far better than humans at, and many other aspects where the reverse is true.

Humans have vastly better spatial memory. This is due to the fact that they are unable to sense it in all directions, like an Eridian can. So if a sudden noise or event removes an Eridian's ability to hear, it will not have any idea what the makeup of the room is unless it put conscious effort into memorizing it in

advance. While a human knows exactly what the room is like behind him, and could even find their way around in the dark.

Eridians are far better at multitasking. They can do multiple completely unrelated things at the same time. They could assemble a model boat with two limbs while doing complex calculus with the other. This is owing to their omnidirectional nature.

Humans are much better at focus. It takes a serious amount of concentration for an Eridian to continue on a single task for a long time. It is unpleasant for them – like doing a thousand arithmetic problems would be for a human. Boredom and mental fatigue set in.

Humans are much stronger at hand-eye coordination. Eridians are quite adept with their limbs, but human hands are simply better. Eridians would never be able to juggle or throw objects accurately like a human can.

Eridians are better at precise memorization. They are much faster than humans at rudimentary math tasks because they have memorized most of the answers. When a human needs to know what 102 x 27 is, they will have to work it out. While an Eridian will just remember the answer as easily as a human would remember the answer to 2 + 2.

Worker Cells and the Colony

The backbone of Eridian biology, the worker cells build, repair, and grow the body as needed. It is these cells that have the genetic information for the Eridian. They are more like the biology that humans are used to. They have membranes, nuclei, and an internal medium of water. They also contain tungsten compounds in their cell wall, which helps make them neutrally buoyant in the extremely dense Eridian blood.

Worker cells reproduce via mitosis. Unlike human cells, there is no single DNA blueprint present. Each worker cell type has its own genetics, and there are thousands of unique types, all specialized for their particular function. Some lay down layers of metal atoms to make bones, others deposit silicon for nerve crystal growth, others deliver the energy molecules around the bodies, etc.

Eridians have to maintain a “colony” within their bodies for the worker cells. It is the breeding ground and safe space for worker cells, as well as the location of the brain. A large percentage of worker cells exist solely to maintain the balance in this colony. Only about 8% of worker cells that venture into the bloodstream and service the body. Fully 20% of them service the brain, while the remaining 72% exist as part of a self-balancing biosphere for the colony. These “Colony Workers” see to an entire closed ecosphere. The energy enters the system via the high-energy molecules harvested by the digestive system.

The colony is the most delicate and critical organ in the body. Not only is the brain there, but it’s also the only place worker cells can breed. The blood inside is not run through blood vessels, but is instead simply a large chamber. It is still in the circulatory system.

The colony is surrounded by a shell of Babbitt Alloy (see “Heat Rejection”). The entrances and exits to it are valved and can be closed by worker cells as needed. This is done both during dormancy, and in the case of severe hyperthermia.

Reproduction

Eridians are hermaphrodites, like most animals on their planet. They lay eggs together in a common area and cover them (Evolutionarily, they bury them, but with the rise of technology they have more advanced means of keeping the eggs safe during gestation). The eggs have nutrients, raw materials, and worker cells from the parents. They also have permeable membranes which start to merge, allowing free flow. The worker cells start by breeding up with the resources that are in use. Within each subtype, one side or the other will overwhelm its competition and “win”. It is largely random which subtype will win and there is an entire evolutionary train having to do with egg competitiveness of worker cells. But in the end, each subtype of worker cell ends up with just one line. These worker cells are functionally the “genes” of the Eridian.

Once all of that is settled, the worker cells get to work making the Eridian. Both parents have a parental instinct toward the offspring. The typical litter size is five. Fives, in general, show up all over the place in Eridian biology.

Biological requirements and tolerances

Eridians are most comfortable at 210°C. They start suffering from heat exhaustion at 230°C (see Heat Rejection). They will die if exposed to temperatures of 240°C or higher for extended time periods. A temperature of 280°C or higher is almost instantly fatal.

Eridians evolved to exist in 28 atm of pressure. A pressure below 19atm is fatal. At this pressure, the ambient temperature of 210°C will boil the water in their worker cells. Like humans, Eridians can handle quite a lot of additional pressure – up to hundreds of atmospheres so long as the air is ammonia. And unlike humans, Eridians don’t need a slow transition from one pressure to another. Their respiration is simply for heat exchange – they don’t absorb or eject gasses during this phase. Also unlike humans they do not have gasses dissolved in their bloodstream.

However, when Eridians eat, they have lower pressure tolerance because that’s the only time their body “opens” and exposes itself to the outside air. The pressure isn’t the problem, but the sheer volume of ammonia molecules becomes deadly to the worker cells.

Eridians are carnivores, eating meat from animals in their biome. The most valuable parts of the animal are its energy nodules, however the bones and other metals are also critical for the Eridian’s nutrition. The worker cells are very adept at extracting elements needed from any source, but the elements have to be present somewhere.

Eridians also eat certain minerals to supplement their diet. This may seem strange, but it’s very similar to humans eating salt.

Electrical system

The hearts provide bloodflow, but also alternate magnetic material back and forth to create a small voltage potential between the bloodstream and the rest of the body. This energy is used by micromuscles.

Average dimensions and weight

An Eridian's thorax is about 60cm across and 20cm tall and roughly pentagonal. A 60cm pentagon (vertex to opposing edge) has a SA of 2365.79 cm^2. That makes for a volume of 47315.8 ccs, which is 0.047 m^2.

Each limb (fully extended) is about 45cm long. It's 10cm at the shoulder and narrows to a point at the claws, with an average diameter of 5cm. That's a total of 3532 ccs. Five limbs make for a total 17662.5 ccs. This makes the total body volume of an Eridian about 0.063 m^3. (63 liters)

The makeup of an Eridian is mostly metals and metallic oxides. Their blood is the heaviest part – being made mostly of mercury.

Arbitrary: We will say that mercury in an Eridian's bloodstream has about the same wall friction as blood in a human system. This means that if the hearts stop beating, the blood will stop moving in about 1 second.

Arbitrary: We will say that Eridian blood represents 10% of their body volume.

The rest of the body is made of mostly metals and oxides, though made in porous, honeycomb structures to enable worker cells access to wherever they need to be. The predominant metal is iron, with a density of 7870 kg/m^3. However, being so porous, there's a lot of empty space. The carapace is made mostly of hematite, with a density of 5260 kg/m^3. The next most common compounds are silicates (basically glass), clocking in at 2700 kg/m^3.

Arbitrary: 70% of the volume of an Eridian is pockets of empty space – largely for muscles to expand into and the insides of honeycomb-like solid structures

Arbitrary: The average density of the non-empty, non-blood parts of an Eridian is 4800 kg/m^3

With all the above information we can guess the mass of an Eridian.

At 10% of their body volume, and having an average volume of 0.063 m^3, That makes 0. 0063 m^3 of mercury, weighing in at 85.6kg.

The remaining 90% of their body is 70% empty space. So the solid material is 90% of 30% of 0.063 m^3. That works out to 0.01701 m^3. At an average density of 4800 kg/m^3, that makes 81.648kg.

The average mass of an Eridian is 167kg.

Worth noting – in their homeworld's gravity (2.09g), they have the effective *weight* that 349kg would have on Earth. As a result, by human standards, Eridians are incredibly strong.

Energy consumption

Eridians are the apex predator on their planet. They eat other animals from the same biosphere. Ultimately, energy in this biosphere is collected via sunlight in plantlike life and works its way up the food chain from there. Eridians have mitochondria, and use ATP as energy storage – just like Earth life does. This is no coincidence. A panspermia event from Tau Ceti billions of years ago seeded life on both Earth and the Eridian homeworld.

I was unable to find consistent data on how many calories a human consumes by lifting a 50kg weight 50 centimeters. However, a human doing "moderate weightlifting" will burn 280 calories per hour. We'll call 50kg (100 lbs total) a moderate amount. We'll say that the moderate weightlifting is 6 sets of 6 reps each every 10 minutes. This can be done 6 times in an hour (we are not accounting for fatigue – just calculating energy of a fresh muscle). That makes for a total of 216 lifts. This means one single lift will consume 1.29 calories.

An Eridian doing the same thing will consume 1.95 calories. Their muscles are less efficient (Ratio: 1.519). Plus, they are much heavier than humans and have a much more energy-intensive circulatory system.

Arbitrary: Eridian bodily functions consume the same percentage of their daily caloric intake as humans do by type except for skeletal movement.

Arbitrary: Eridians use more total movement energy as a function of their ***weight*** *(not mass) ratio to humans. Eridians use less skeletal muscle energy as a function of their muscular efficiency to humans*.

(https://www.sciencelearn.org.nz/resources/1835-energy-requirements-of-the-body)

A human body uses 60% of its energy on resting metabolism, and an additional 8% on Thermic effect (digesting food). This leaves 32% for physical activity. Note that the heart is part of "resting metabolism".

The last thing we need to work out is how much harder it is to move an Eridian body around than a human one. Their homeworld gravity is higher and they are heavier. How much effort is consumed by fighting gravity and how much is consumed by overcoming inertia?

Arbitrary: We use 15% of our muscle energy overcoming gravity, and the remainder overcoming intertia.

The average human diet is around 2000 calories – meaning 640 calories goes to physical activity. That means 96 calories per day is used fighting gravity and 544 is used fighting our own inertia.

Eridians consume 1.52 as much energy as a human doing the same task. Their mass is about 167kg to a human's 100kg – making for a factor of 1.67. Multiplying those means they consume 2.54 times as much energy as a human on non-gravity related tasks. For gravity related tasks, they consume 5.31 times as much (efficiency 1.52 * mass ratio 1.67 * gravity ratio 2.09).

544 calories on non-gravity-related tasks becomes 1,382 calories for the Eridian. 96 calories per day on gravity-related tasks energy becomes 510 calories. So an Eridian consumes 1,892 calories per day on physical activity.

Since physical activity is 32% of the total metabolism, this means an Eridian consumes 5913 calories per (Earth) day. An Earth day, of course, has no meaning to the Eridian biosphere. So this is better described as saying they consume 286 W. (For reference, a human works out to be about 96 W)

Eating Frequency

Broadly speaking, Eridians need to have three times the calorie input that humans do (they consume 286W to a human's 96W). Fortunately, everything else in their biosphere is extremely energy rich.

Eridians separate and crunch up their food with their hands. Originally they would butcher carcasses barehanded but they have more socially calm means of eating now. Still, eating involves a long process of separating the useful parts of a prey animal from the less useful parts. When the time comes to actually bring the food into the body, the substance is well-balanced and nutritional with a very high energy content. Close to 8 times the energy density of a human meal, with all the needed nutrients. The total volume of material consumed is about four times the volume of a typical human meal.

This means that an Eridian, in a single "meal" consumes 32 "human meals" worth of food. Presuming a human meal is enough to satisfy a human for 8 hours, that makes it 2.764e6 Joules of energy. This means an Eridian meal is about 8.844e7 Joules, which is enough to last them 86 hours – just under 4 Earth days, and about 17 of their days (their days are 5.1 hours each).

Heat Rejection

One of the most important aspects of Eridian physiology is heat rejection. Their entire muscular system operates on heat differential. Their ACS must remain at or near 210°C, while their HCS operates at 305°C. The HCS temperature is largely irrelevant – it's more than the boiling point of water which is all that matters.

Broadly speaking, the ACS is approximately "cold blooded". It is the same temperature as the outside air. But if the temperature drops below 210°C, the HCS will start directly heating the ACS back up to normal. But ignoring severe weather, the outside air (mostly ammonia) is 210°C. And the Eridian needs to radiate away 286W of energy continually. It does this via a cooling lattice on the top of its carapace.

This lattice is a rigid set of capillaries, making a porous material that is sponge-like in appearance, though it is completely rigid. This lies under the "cap" segment at the top of the body, and air gets to it through carapace baffles. This evolved for defense. Damage to the heat rejection capillaries would cause major bleeding.

The Eridian "breathes" by pulling air in through the baffled vents and then out through other vents. This air-cooling system is not an "internal organ", properly speaking. It's a concave alcove, but still outside the body. The air never mingles with the blood.

After some research, I found that the math surrounding thermal transfer from one material to another is very complex. Especially when there is air convection involved. So instead of working all that out, I will say this:

Arbitrary: An Eridian's heat dissipation fins are 20% as effective at heat rejection as a modern CPU heat sink. And an Eridian's maximum allowable blood temperature is 214°C. An Eridian "breathes" by pulling air across its capillaries at about 1 m/s.

Worth noting: The atmosphere (ammonia) of the Eridian homeworld is twice as effective at heat transfer. This means they are effectively 40% the efficiency of a CPU heat sink.

The capillary bundle is just under 3cm tall, and occupies 60% of the top (inside) surface area of the cap segment. It is roughly half capillary material and half empty space for air to flow through. There are five "in" vents and five "out" vents. The in-vents are around the perimeter of the cap segment, while the out-vents exit upwards through the top.

"Breathing" is done by means of a diaphragm below the capillary bundle. The vents have valves that open and close due to pressure differential. They are not perfect seals – they don't have to be. They are on the order of 98% effective, though. The diaphragm moves down, pulling cool air in through the in-vents, then moves up, pushing the now heated air through the out-vents.

How long can they "hold their breath"?

Things start going downhill for them quickly as their ACS temperature increases. At 214 degrees, the most delicate of the worker cells start retreating into the colony. By 216 degrees, all worker cells will retreat to the colony and it will seal off to slow the advancing heat. At this point a reservoir of endothermic dissolution will be initiated within the colony they reduce the temperature, but it is a limited resource that can only be restored when temperatures are normal.

The Eridian will feel sluggish and will start aching all over – the worker cells are not doing their jobs.

At 223°C, the insulating layer around the colony will begin to melt. This is a deliberate evolved trait – the state change will absorb heat for a while as a last-ditch effort. But it only lasts about 15 minutes before the insulation is gone. Within five minutes from that, the colony itself will be 223°C. At this point the worker cells will die. There is no coming back from this. The Eridian is dead.

They have 85kg of mercury in their bloodstream. It will receive 221.7W of power. It starts at 210°C and serious hyperthermia will set in at 223°C. Mercury has a specific heat of 0.140 J/g*K = 140 J/kg*K. It has to increase in temperature by 13K and there is 85kg of it. This will take 697 seconds = 11 minutes. Then there is another 15 minutes to breach the colony wall and another 5 to heat up the colony. So the grand total is 31 minutes.

So if they can't "breathe" for half an hour they'll die. But how long until they become sluggish? For that, they need only get to 214°C. That only takes a few minutes.

Note: The state change material is called "Babbitt Alloy No. 1" by Earth scientists. It is the following alloy: 90.7% Tin, 4.5% Antimony, 4.5% Copper, 0.3% Lead.

https://en.wikipedia.org/wiki/Babbitt_(alloy)#Babbitt_alloys

https://www.makeitfrom.com/material-properties/Grade-1-L13910-Tin-Base-Babbitt-Metal

The heat of Fusion is 70 J/g.

Radiation Problems

Humans—and most other life on Earth—has radiation resistance built in at the lowest levels. DNA has redundancy, there are evolved mechanisms to repair transcription errors, cells evolved to simply die if there's too much damage to their genetic code, and will actively commit suicide if they are at risk of going cancerous. Also, telomeres help stop the spread of cancer. And, being mostly made of water helps a lot, as water is an extremely good radiation shield.

Eridians did not evolve any of that. Their planet's extremely strong magnetic field, plus the very thick atmosphere prevents almost all radiation from reaching the surface. Also, having metallic blood just makes things worse. While the blood does provide some protection to the colony from direct radiation, the mercury itself then becomes radioactive. It causes more problems than it solves. And the extremely low water content of an Eridian's body provides no effective shielding.

Basic aspects of culture and civilization

Eridian cultures and history are as complex and detailed as human cultures and history. But some information worth noting:

- They use base 6 as their mathematical system. Most likely because they usually stand with three limbs and use two for grasping. This gives them six fingers to hold up.
- They are more advanced than humans in some fields – especially math and materials science. But they are behind on many technologies, notably computers and they have no notion of relativity.
- Lacking a sense of sight, their "writing" requires texture or acoustical changes in the medium.
    - Their earliest writing was simply divots in clay (same as humans).
    - Modern handwriting uses a "pen" that lays down a thick layer of substance on a substrate. So, slightly thicker paper equivalent, and much thicker ink – it stands around 1mm off the surface.
    - Printed writing is much more efficient and crisp, and takes the form of holes in the page instead of raised surfaces. This way, the book takes less space.
    - The primary output device for an Eridian computer is a textured monitor. The pixels, instead of changing color, rise and fall from the default level, making a texture that the Eridian can sense with hearing. Pixels can also change their sound absorption properties for added quality. This is like the difference between color and black-and-white TV.
- Eridians can hear through walls and make out the environment beyond those walls in the same way we can see through glass. And of course they can hear conversation through walls extremely well. So their walls are very soundproof.
- They are helpless when sleeping, so they evolved to watch over each other. That was part of them evolving to be a communal and cooperative species in the first place. Natural threats are long gone, but they still have an instinct to be watched while sleeping. It's not overpowering, but it is comforting. Compare it to a human with a blanket. You can sleep without one, but you'd rather have one if possible.

Eridian's ship

Eridian's ship is much larger than the Hail Mary, and it set out with 31 million kg of Astrophage fuel.

They were unaware of relativistic physics, and as a result, had far more fuel than they needed to get to Tau Ceti. They were also unaware of how high radiation risk is when traveling so fast. The entire crew died except one Eridian, who was in the engineering section and surrounded by Astrophage.

The ship is made of their advanced materials and holds their 28atm pressure.

Like the Hail Mary, it has fabrication capabilities, though they are based on milling and molding. They don't have computers capable of 3D printing. They had a (now dead) craftsman aboard.

Life support

The ship provides 29 atmospheres of ammonia at a comfortable 210C. It also maintains a magnetic field oriented at the nose to provide an analog to Beemin's natural magnetic field. Without a magnetic field present, Eridians get disoriented and confused.

Eridians have no need for artificial gravity. Their astronauts, like ours, are trained in how to deal with zero-g. Plus with five hands they are able to easily move around via handholds at all times in any direction. Their ships simply have a lot of places to grab hold of.

Like humans, Eridians left in zero-g for long periods of time can suffer physical problems. But their issues are far less severe than humans end up with. The bulk of their bodies are made of non-living tissue and are thus unaffected. The colony itself is basically a fluid-filled sac with monocellular organisms swimming around. And they evolved to be able to move around, turn upside down without dying, etc. So that works fine. The only issues they face are when excreting and eating. Both require gravity to work correctly. Most critically, the incision and healing of the fissure in the abdomen that accompanies digestion. That process does not work correctly in zero-g. So the ship has a centrifuge aboard specifically for sitting in while eating and excreting.

If that centrifuge were to break, they would simply use the ship's engines to provide thrust during the critical three hours or so of eating.

If that also weren't an option, they would end up with poorly-healed abdominal wounds and would be susceptible to infection—a very serious and potentially fatal problem.

Timekeeping

Though the land level of their homeworld is shrouded in darkness due to the thick atmosphere and life forms above, Eridians still have an intrinsic knowledge of the day-night cycle. Simply because the temperature goes up and down as a result. Plus, the whole planet evolved to capitalize on that cycle, so many of the Eridians' internal rhythms operate this way. For instance, their dormancy periods are usually two to three Eridian days. One day is 5.1 earth hours.

The normal “comfortable” means of being for an Eridian is three limbs on the ground and two to use tools. As a result, they have a base-6 counting system (two hands, three fingers each). Their timekeeping is metric, meaning they use their counting base as the primary system.

For the sake of clarity, all base-6 numbers will be written in RED.

Their day is 18397.44 Earth seconds long, which they divide into 10,000 base-6 units. That’s 7776 in base 10. Each unit is 2.366 earth seconds long.

They tend to go dormant at night, because the cooler air enables them to cool off their HCS faster. That’s the evolved response. Nowadays, their bedrooms are kept nice and cold to let them have a good night’s sleep. As a result, they consider the coldest part of the day to be the day divider – more or less the same as humans. Their “midnight” is 0000.

Their counting system is:

ℓ, I, V, λ,+, ⅄,

How they made Astrophage

Erid has the advantage of oceans that are 202 degrees Celsius. When Astrophage are exposed to water at this temperature, they have a doubling time of 32 days. The Eridians used orbital platforms (on their space elevator) to produce 10g of Astrophage via direct sunlight focusing and imported CO2.

From there, they had a sea-based manufacturing facility that constantly exposed Astrophage to ocean water, and imbued it with CO2 and IR light as needed to make it breed. This enabled them to have a geometric progression of Astrophage population, culminating in the desired 3e7 kg of Astrophage fuel for the *Blip-A* after just 2.7 Earth years of production. It did not come without a cost, though. Their already-suffering ocean temperature was reduced by 0.18 degrees Celsius as a result. This had devastating effects on their ocean biomes. Most life on Erid evolved to live within extremely narrow temperature ranges owing to the extremely stable conditions at the surface.